COMPETITION ECONOMISTS GROUP

Stranding risk
depreciation vs uplift

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Table of Contents

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List of Figures

List of Tables

1 Introduction and overview

1. We have been engaged by the Australian Pipeline and Gas Association (APGA) to provide our opinion as economists on remedies to address the stranding of investment in regulated gas pipeline businesses.

2. Stranding occurs when businesses can no longer expect to recover previously sunk investments in providing regulated services. In the absence of measures to address stranding risk, and provide for an expectation of cost recovery, investors will be discouraged from making investments to support the provision of the specific regulated service and regulated services more generally. The likelihood and magnitude of stranding for a regulated business is influenced by the cost recovery path determined by regulators. This cost recovery path is determined by the rate at which capital is returned to investors (i.e., deprecation).

3. In this report we model the relationship between the rate that capital is returned to investors, the expected cost of future asset stranding and the compensation required for expected asset stranding.

4. We show the following:

    a. An acceleration in the rate of deprecation will reduce the likelihood and expected cost of stranding and, therefore, reduce the level of compensation required for that stranding. Accelerated depreciation can be achieved by shortening asset lives, ceasing to index the RAB for inflation and/or adopting diminishing value methods for depreciation. The New Zealand Commerce Commission is considering all of these policy responses to the risk of economic stranding of gas pipeline businesses in New Zealand.

    b. Measures to address stranding risk such as an *ex ante* stranding uplift to the WACC (consistent with a self-insurance cost) and accelerated depreciation can be shown to be largely equivalent.

    c. Although some regulators have tried to introduce models to compensate for stranding risks, to date, these models are still rather underdeveloped and do not realistically model the circumstances of regulated gas pipeline businesses.

    d. We develop a more realistic model. The model is based on illustrative assumptions about the path for future gas demand. However, under plausible scenarios where demand for natural gas falls close to zero by 2050, the model outputs suggest a strong case for immediate action by the AER. Even were gas demand were not forecast to fall to ever fall to zero, economic stranding of assets is likely in many scenarios[1] and immediate action would be necessary to address that risk.

e. The model also shows the trade-off between accelerated depreciation and the required *ex ante* uplift to compensate for expected stranding costs. Specifically, the faster the accelerated depreciation the lower the *ex ante* uplift.

f. If the window of opportunity to address stranding risk is missed, regulators may have no capacity to address the effects of stranding risk. If that is the case, then it is likely that at some future date there will be no chance to re-direct the recovery pathway.).

[1] Notably, a gas network that continues to operate in the long run with revenues above avoidable costs but below those necessary to recover their historically sunk investment will be subject to a level of economic stranding.

2 Stranding risk

5. In this section we discuss some economic considerations relating to approaches to address the risk of stranding.

2.1 What is stranding risk?

6. Whenever costs are incurred in advance of receiving revenues there is a risk that such expenditures will not be recovered. The inability to recover past expenditures, including a normal return, results in those costs being stranded. A common reason that costs may be stranded is because of unexpected reductions in demand for the product. The reduction in demand may be for a range of reasons including unexpected advancement in competing technologies, changing consumer preferences or interventions by government to restrict demand.

7. In a regulated setting, prices are typically held below the willingness to pay of consumers.[2] Regulators also smooth the recovery of costs. They do this by adopting a depreciation profile that achieves a path of prices that is considered to be desirable and which, ideally, aims to promote economic efficiency.[3]

8. In the absence of any probability of stranding, the regulated firm may be indifferent between the regulator's choice of depreciation profile. This indifference to the profile of depreciation is commonly referred to as the Invariance Proposition.[4] It says that if the depreciation profile is determined such that the present value of future income streams is zero in each period over the life of the asset (discounted at the allowed rate of return) investors will be assured cost recovery (at least in expectation). Hence, they will be indifferent between depreciation profiles selected by the regulator.

9. However, once we introduce a positive probability of stranding, the Invariance Proposition no longer holds. The regulated firm will no longer be indifferent between

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[2] In unregulated settings, a firm will only incur costs if they expected to at least earn a normal return. The risk of stranded costs in this setting is borne by the firm. The compensation for assuming this risk is in the upside returns in circumstances that stranding does not occur. In a competitive market this upside is constrained by the potential for entry – which is in turn informed by "the market's" perceptions of stranding risks.

[3] This would entail setting prices such that they minimise dead-weight loss. In effect, this would be an intertemporal application of the well-known Ramsey pricing problem. Prices, or the level of depreciation of the asset, would be set in each period to maximise use of the service over the life of the asset. This would require recovering a greater proportion of costs in periods where demand was relatively less sensitive to higher prices (the inverse elasticity rule) See Baumol, W. J. (1971). Optimal Depreciation Policy: Pricing the Products of Durable Assets. The Bell Journal of Economics and Management Science, 2(2), 638

[4] Schmalensee, Richard, 1989. "An Expository Note on Depreciation and Profitability under Rate-of-Return Regulation," Journal of Regulatory Economics, Springer, vol. 1(3), pages 293-98, September.

the regulator's choice of depreciation profiles if some of those profiles backload depreciation into periods such that the allowed prices will be above consumer's willingness to pay (i.e., cause stranding to occur).

10. In practice, the likelihood and the degree of stranding may not be known with certainty. There will be some states of the world in which stranding will occur and in other states of the world stranding might not occur. Hence the terminology of stranding "risk".

11. Without explicit allowance for the possible states of the world in which stranding might occur, investors face an asymmetry. Investors face the potential for there to be a downside without any commensurate potential for upside.[5] This asymmetry means a key principle of regulation is no longer adhered to – that of giving investors an expectation, or a fair bet, that they will be able to recover the cost of investing in assets to provide regulated services.

2.2 What creates stranding risk?

12. In a regulatory regime where a regulated business could choose their own deprecation profile, but still be subject to an NPV=0 long term cost recovery constraint, the business would have an incentive and ability to adjust its price path to reduce the risk or size of potential stranding. Firms could tilt the recovery of costs to earlier periods such that higher prices today would be in lieu of materially lower prices in the future (given the impact of discounting within an NPV=0 constraint). Stranding is made less likely because materially lower future prices are less likely to be above consumers' willingness to pay.

13. It is, therefore, the regulator's choice of depreciation profile that determines the size of stranding risks. A regulator that adopts a heavily backloaded depreciation will create or increase the risk of stranding, whilst a regulator that adopts a more frontloaded deprecation profile will reduce the risk of stranding, other things equal.

2.3 Why address stranding risk?

14. This section discusses the reasons for addressing stranding risk.

15. The two primary grounds for addressing stranding risk relate to providing surety for future investment. The first ground is economic efficiency. Denying the opportunity to recover costs risks raising perceived cost of doing business above the competitive

5 The nature of regulation is that it caps the potential upside to be a normal rate of return.

level leading to a lower than optimal allocation of investment in the provisions of services. [6]

16. If stranding occurs due to government fiat, this may be viewed by financial markets as a form of opportunism. Participants in financial markets would incur greater transaction costs in investing in regulated sectors exposed to the potential for stranding. This could create distortions in decision making to the detriment of economic efficiency. This is especially true if one arm or government (the economic regulator) does not allow the regulated business to take actions (e.g., accelerated depreciation) to minimise the expected cost of stranding due to the actions of other arms of government (e.g., the arm of government(s) charged with implementing climate policy).

17. The second ground for addressing stranding risk is to ensure regulation is consistent with an implied compact between current and future consumers. In this framework, the regulator acts as an arbitrator of a fair deal between current and future consumers. In the absence of long-term agreements with consumers, or exit fees, consumers that continue to use services when demand falls are exposed to price increases. This involves a burden shift from consumers that no longer use the regulated service to consumer that continue to do so.

18. If demand falls to a significant extent the higher prices charged to consumers who continue to acquire services may be insufficient to achieve cost recovery. This would ultimately result in price spiral with the price increases resulting from falling demand perpetuating further reductions in demand, ultimately resulting in asset stranding.

19. This was the AER's logic for accelerating depreciation in the face of potential falls in future demand.[7]

> *"As consumers make the switch to renewable energy under the ACT Government's climate change strategy it's expected there will be less demand for gas in the ACT," Ms Savage said.*
>
> *"This means any remaining consumers who can't or don't yet choose renewable energy services are at risk of future bill increases because less homes and businesses can share the cost of maintaining gas network services.*
>
> *"To minimise future price increases, particularly for vulnerable consumers that might not be able to afford to switch, the AER's decision allows*

6 Brennan, T. J., & Boyd, J. (1997). Journal of Regulatory Economics, 11(1), 41–54

7 AER, press release *AER allows revenue to support gas consumers in transition to renewable, 30 April 2021.*

Evoenergy to accelerate the depreciation of new gas pipeline assets in NSW and the ACT.

"Faster depreciation means that some of the costs for gas network services can be recovered from more consumers today, compared to a smaller number of consumers in the future

20. Setting faster regulatory deprecation to minimise stranding risks is a means to determine a fair deal between consumer and investors, as well as between current and future consumers.

21. A third ground for addressing stranding risk is to minimise the potential for future stranding events to precipitate financial distress for network service providers. The modelling in this report, even though only illustrative at a high level, suggests that, if the AER does not take material action now, there is a significant risk that networks will face asset impairment in the medium to longer term. That is, there is a risk that auditors will form the opinion that networks will not be able to recover the carrying value of the network assets. The same circumstances can be expected to place pressure on credit ratings for regulated gas networks and raise the perceived risk of insolvency.

22. That is not to say that network businesses will actually become insolvent, but they may incur real costs in managing heightened insolvency risk. If actual or perceived insolvency risk exists, the focus of the firm shifts from prudent decisions with the objective of maximising the long-term value of the assets to a short-term focus on generating enough cash to meet debt obligations falling due. Long term planning and investment are put on hold because equity holders and management (correctly) perceive that the firm will not make it to the long term unless it meets those debt obligations (at least not in its currently structured form).

23. In the finance literature it is recognised that high costs associated with insolvency/bankruptcy cause firms to both spread their debt maturities out through time and not to adopt extreme levels of gearing (despite tax advantages of gearing). Baxter (1967)[8] was one of the first to make this point but many authors have built on his insight since.[9]

24. Depending on the nature of the contracts with debt holders, insolvency may also give rise to debt holders taking full or partial control of the company and, potentially, to

8 Baxter, N., "Leverage, Risk of Ruin and the Cost of Capital," Journal of Finance 22, September 1967, pp. 3956-403.

9 For example: Stiglitz, J.E., "A Re-Examination of the Modigliani-Miller Theorem," American Economic Review 59, December 1972, pp. 784-793; Kraus, A. and R.H. Litzenberger, "A State Preference Model of Optimal Financial Leverage," Journal of Finance, September 1973, pp. 911-922; and Kim, E.H., "A Mean-Variance Theory of Optimal Capital Structure and Corporate Debt Capacity," Journal of Finance 33, March 1978, pp. 45-63.

bankruptcy proceedings. Protracted legal battles may ensue between debt and equity holders (and between different groups of debt/equity holders) over the future of the firm. This may paralyse management, with the principal focus being on the division of the existing value of the firm (and debt holders attempting to ensure the maximum repayment of their debts) rather than on maximising the total value of the firm (including the equity stake).

25. The disastrous nature of the potential transaction costs associated with insolvency (and bankruptcy) are precisely why corporate treasurers will do everything in their power to prevent this occurring.

26. If regulatory inaction does lead to asset impairment and financial stress it is important to recognise that, although insolvency/bankruptcy may be highly unlikely to result, gas networks will incur material, and otherwise avoidable, costs associated with managing insolvency risk. That is, the actions networks will have to take to avoid insolvency/bankruptcy will be costly. This may take the form of hoarding cash by foregoing what would otherwise be sensible (NPV positive) investments or running down existing assets. It may also take the form of costly equity capital raising and more expensive debt costs.

27. These considerations underline the fourth ground for acting now to minimise stranding risks – creating option value for a potential transition to clean hydrogen. Accelerating depreciation now has the potential to lower future prices for gas transport faced by customers. Lower prices for gas transport have the potential to incentivise alternative 'clean hydrogen' uses of existing gas networks. Thus, higher prices now may create higher long run demand for network services.

28. It is possible that any transition to clean hydrogen will involve complexity and investments by networks (in physical maintenance and technical expertise capital but also, potentially, in loss leading provision of below cost network services). A network owner that is in a sound financial position, and which has had a positive experience with a flexible regulatory regime, will be best placed to make these investments.

29. That is, accelerating depreciation now may act as a signal that the regulator and the network will work together in stewarding the network assets through an uncertain future. Promoting a goal of maximising the long run value that continuing to maintain and enhance the usefulness of the assets for future generations.

3 Modelling stranding risk

3.1 Overview

30. This section explores the modelling of stranding risk and, to the extent that stranding risk cannot be eliminated, how to model the necessary *ex ante* compensation for that residual stranding risk.

31. We have already noted that Schmalensee (1989) demonstrated the Invariance Proposition which states that, in the absence of stranding risk, investors are indifferent about the time profile over which they recover their investments.

32. However, it is also recognised in that, in the presence of stranding risk, this is no longer true. Crew and Kleindorfer show that accelerated capital recovery may be necessary to eliminate or reduce the expected cost of stranding:[10]

> *… under conditions of competition and technological progress, front-loading of capital recovery is essential if the regulated firm is to remain viable. In addition, if the introduction of accelerated capital recovery is delayed by regulators, they may effectively vitiate any opportunity of the firm to recover its invested capital. The breathing space, or period of time, that the regulators can delay introducing the application of efficient capital recovery without ultimately compromising the firm's ability to recover its invested capital is called the "Window of Opportunity" (WOO).*

33. This passage highlights a critical relationship, and trade-off, between:

- The rate at which capital is returned to investors;
- The expected cost of stranding of future stranding; and
- The necessary compensation 'stranding uplift' now if the expected cost of future stranding cannot be eliminated.

34. Holding other things equal, the slower the rate that capital is returned to investors the higher the expected cost of future asset stranding and the higher the compensation required for that asset stranding.

35. In the rest of this section, this relationship is explored within two different modelling frameworks.

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10 Crew, Michael A & Kleindorfer, Paul R, 1992. "Economic Depreciation and the Regulated Firm under Competition and Technological Change," Journal of Regulatory Economics, Springer, vol. 4(1), pages 51-61.

3.1.1 The NZCC modelling framework applied to Chorus

36. In section 3.2, we apply the modelling framework that the New Zealand Commerce Commission (NZCC) used to estimate a stranding uplift to compensate Chorus for stranding risk. This stranding uplift was applied as a percentage of the RAB and, in this sense, it can be thought of as a "WACC uplift". However, the correct way to conceive of this is as an increase in the "promised return" absent stranding in order to make the "expected return" equal to the WACC. That is, the "WACC uplift" does not result in an increase in expected returns above WACC – it merely raises expected returns to be equal to WACC (where they would otherwise be below the WACC absent the uplift due to stranding risk).

37. With plausible assumptions about potential asset stranding by 2050, this modelling suggests a very high stranding uplift for stranding (greater than 5%).

38. The modelled stranding uplift can be reduced by applying accelerated depreciation. However, even with extremely high levels of accelerated depreciation the need for a stranding uplift cannot be eliminated within this modelling framework. For example, even if compensation for capital costs was initially quadrupled (such that capital cost compensation fell to effectively zero by 2040) a 1.45% stranding uplift would still be required.

39. This is because, implicit in the modelling framework applied by the NZCC, there is an assumption that the probability of stranding by 2050 is simply the accumulation of a continuous constant risk of stranding per unit of time between now and then. This means that, even if 100% past capital investment was to be returned at the end of one year, the investors would still be exposed to material asset stranding risk within that year. Therefore, the only accelerated depreciation that can remove stranding risk altogether is instantaneous return of past investments (i.e., in the first second of the next regulatory period).

3.1.2 Modelling the path of future gas demand

40. In section 3.3 we adopt an alternative model that does not assume a constant continuous constant risk of stranding per unit of time. Instead, we assume a time path of for the demand (willingness to pay) for gas transport and a time path for the recovery of costs (past investments plus ongoing costs). So long as the latter is below the former, the business can recover its costs. However, if the former drops (or has a positive probability of dropping) below the latter, then there is an expected cost of stranding (revenues falling below costs).

41. The model assumes that the regulated business will continue to operate the business so long as revenues exceed 'stay-in-business' costs. This is true even when revenues fall below regulated building block costs (inclusive of the cost of sunk investments). However, once aggregate customer willingness to pay falls below stay-in-business

costs, the services will cease to be supplied. The total stranding cost is modelled as the sum of the following in present value terms:

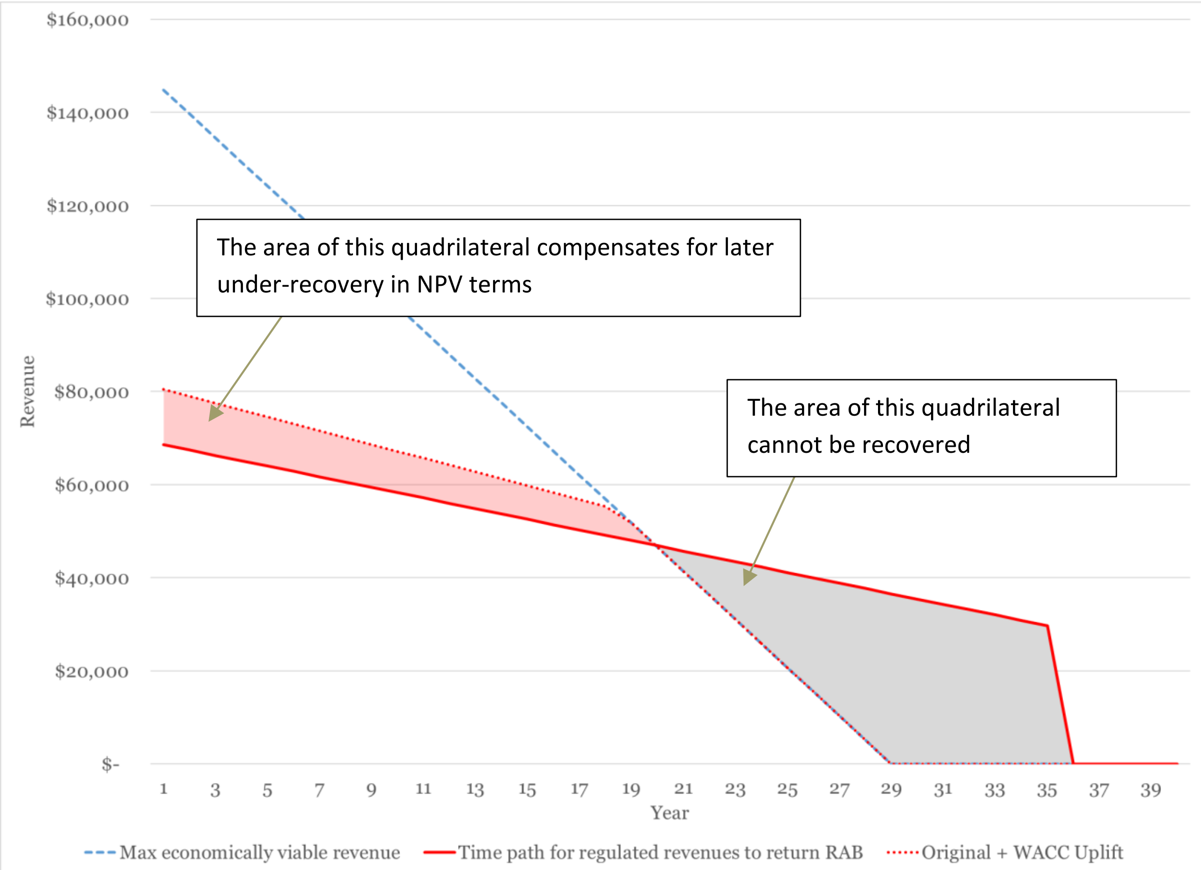
- The difference between building block costs and revenues while the business continues to operate at revenues less than building block costs; plus
- The value of the unrecovered RAB at the time the network is closed (when revenues fall below stay-in-business costs).

42. The stranding uplift is calculated to generate the same present value of revenues above/below building block costs prior/after customers' willingness to pay falls below building block costs. This is illustrated in Figure 3-1 below, where, for simplicity, we have assumed the only costs are the recovery of previously sunk costs (zero operating and capital expenditures) and that the regulator has set a path for full recovery of those sunk costs over 35 years.

43. However, in this illustration the maximum viable contribution to sunk costs is given by the blue line and this cuts below the regulator's path for cost recovery from year 20 onwards. Between years 20 and 28 the business can earn some revenues towards its sunk investments. However, from beyond year 28 revenues make zero contribution to sunk costs. This means that the loss to the business is given by the area of the quadrilateral at the bottom right of Figure 3-1. This is the difference between building block costs and revenues from year 20 onwards.

44. To compensate for this loss there needs to be an uplift in regulated revenues above building block costs prior to year 20 (shown by the dotted red line). This uplift needs to be calibrated so that the area under the upper left-hand quadrilateral (bounded by the dotted and unbroken red lines) is equal in present value terms to the bottom right quadrilateral. Because of the effects of compounding, the upper left quadrilateral is smaller than the bottom right quadrilateral.

Figure 3-1: CEG framework for modelling stranding risk



Source: CEG illustration

45. We use this basic model to generate some more complex modelling in section 3.3 below. Under this model it is, at least in some circumstances, possible to accelerate depreciation sufficiently to eliminate the need for any stranding uplift.

3.2 The NZCC method applied to Chorus

46. In this section we apply the NZCC approach to estimating an uplift to the WACC for exposure to stranding risk for Chorus. The NZCC approach relied on a modelling framework developed by Dixit and Pindyck.[11] In doing so, the NZCC made the following implicit and explicit assumptions:

    a. That cash-flows above avoidable costs are a perpetuity (this could be associated with zero capital expenditure or capital expenditure equal to depreciation such that the RAB is in a steady state).

11 Dixit and Pindyck "Investment under Uncertainty" (1994), Princeton University Press, pages 200 to 207

b. An assumption about the probability of a certain percentage of RAB being stranded over the next N years. For Chorus, the NZCC thought it was reasonable to assume slightly less than a 5-10% probability that 10-20% of the RAB would be stranded at some point (i.e., cumulatively) over the next 10 years.[12]

c. Assume that the stranding risk in b. results from a process where there is a constant per annum stranding risk.

d. Back solve from a. b. and c. what an implied annual risk of stranding is and, therefore, what annual compensation is required. This is how the NZCC arrived at 10bp ex ante uplift. In effect, the NZCC has assumed, based on a. b. and c., that there is an effective 0.1% risk of 100% asset stranding in each year (which is also equivalent to an A% risk of B% stranding in each year – where A×B=0.1% (e.g., a 1% chance of 10% stranding each year).

47. For gas pipeline businesses there is, arguably, a much more material risk of stranding by 2050. For example, the New Zealand Climate Change Commission has recommended to the New Zealand Government that it pursue policies aimed at achieving zero natural gas consumption by residential and commercial customers by 2050.[13] These policies include banning new gas connections. Similar policies have been announced[14] or are under consideration[15] by State governments in Australia and governments internationally.[16]

48. The CSIRO has recently released modelling of the future demand to natural gas and other energy sources.[17] The CSIRO has modelled four paths to a low emissions future for the Australian economy and, in all of these, there is close to zero demand for natural gas in residential buildings by 2050 and, in all but one, a halving of natural gas for industrial purposes.[18] While in one scenario "hydrogen superpower"

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12 NZCC Fibre input methodologies: Main final decisions – reasons paper, 13 October 2020, p. 599. The Commission actually determined this as the midpoint but chose a level of compensation associated with a lower level of stranding risk in order to, in its view, better serve the relevant legislative objectives it is required to have regard to.

13 New Zealand Climate Change Commission, Scenarios dataset for the Commission's 2021 Final Advice (output from ENZ model), 9-Jun-21.

14 https://www.cmtedd.act.gov.au/open_government/inform/act_government_media_releases/rattenbury/2020/act-gas-phase-out-gaining-momentum

15 https://www.infrastructurevictoria.com.au/project/infrastructure-victoria-advice-on-gas-infrastructure/?#about

16 https://www.scientificamerican.com/article/california-is-closing-the-door-to-gas-in-new-homes/

17 Reedman, L.J., Chew, M.S., Gordon, J., Sue, W., Brinsmead, T.S., Hayward, J.A. and Havas, L. 2021. Multi-sector energy modelling, CSIRO, Australia, July 2021.

18 Ibid, p. 44.

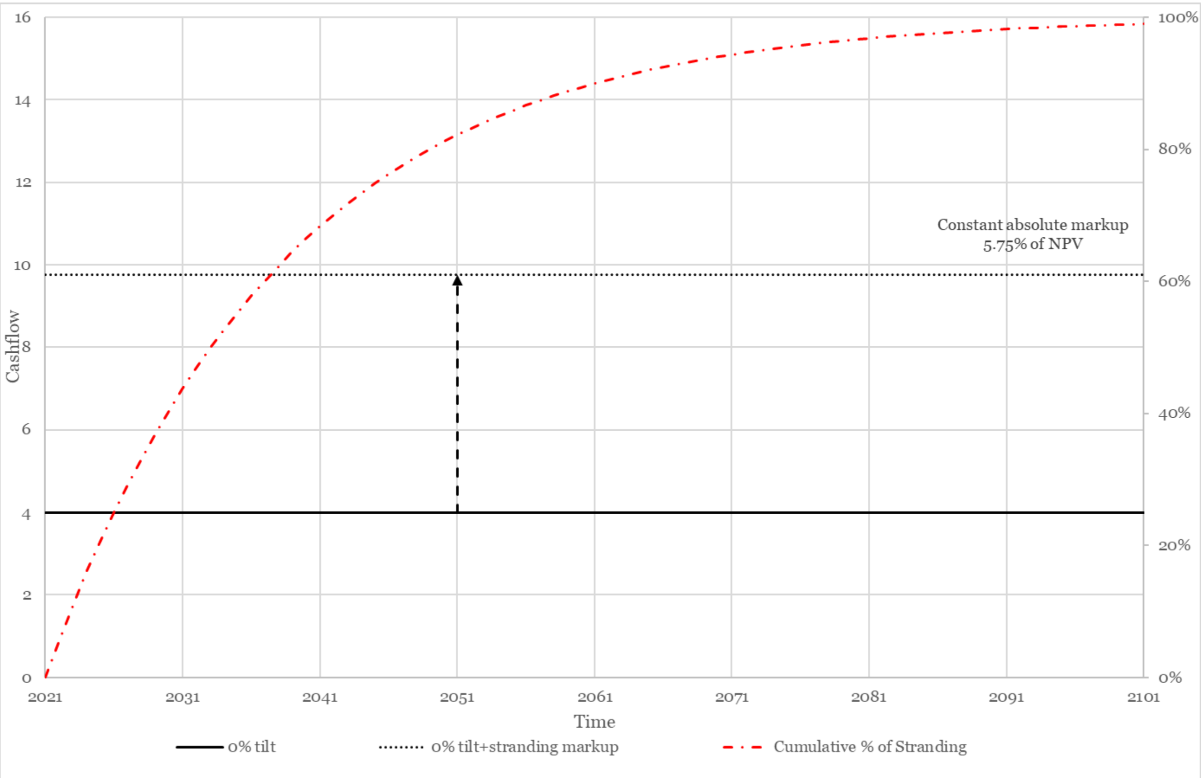
industrial and natural gas is largely replaced by hydrogen, this transition may not make the same use of existing pipeline assets.

49. In this context, it is plausible to assume a high probability that any unrecovered assets in 2050 will be stranded. In what follows, we use the NZCC modelling framework to estimate the stranding uplift if, by 2050, there is an 80% probability that 100% of the asset is stranded. If we do this, then there is a 5.75% per annum required uplift for stranding risks.

50. We illustrate this model visually in Figure 3-2 below. The red dotted line is the cumulative risk of asset stranding assuming 5.75% annual risk of asset stranding. This line is plotted relative to the right-hand axis. It can be seen that 5.75% annual stranding risk compounds to a cumulative stranding risk of 25% after 5 years and 80% after 28 years (i.e., by 2050).

51. The solid black line in the illustration (plotted against the left-hand axis) is the value of a perpetuity. The level of this perpetuity is $4.00 which can be thought of as a 4.00% real WACC applied to a constant real regulated asset base of $100.[19] The dotted black line represents the perpetuity plus the stranding uplift of 5.75%

Figure 3-2: NZCC methodology



Source: CEG Analysis

19 Consistent with the Commission's modelling for Chorus this is a perpetuity which implies either zero real depreciation with zero capex or capex equal to depreciation (i.e., a steady state RAB).

52. A 5.75% stranding uplift is greater than the real WACC itself and, in our view, is likely to overstate the true required uplift for stranding risk – even if there is an 80% probability of 100% asset stranding by 2050. This is because:

- The implicit assumption of constant annual stranding risk is extreme and tends to overestimate the potential for cash-flows to be impaired in early years;
- The assumption of a perpetuity of cash-flows assumes no preventative action is taken to avoid/reduce stranding by 2050. It implies that there is no acceleration of deprecation (or reduction in new investment relative to depreciation).

53. Assuming a constant annual stranding risk is akin to assuming that regulated gas businesses are just as likely to be unable to recover their regulated revenues in 2022 as in 2050 (and in every year in between). This assumption makes sense if one is modelling the expected costs from a random event, such as an earthquake, but makes less sense when the source of stranding relates to the inability to recover regulated revenues at some future point in time.

54. This type of stranding risk cannot be easily dealt with in the Dixit and Pindyck framework and that is why we explore a different framework in section 3.3 below. That is not to say that a version of the Dixit and Pindyck model, with rising annual probability of stranding over time, could not be implemented. Indeed, in a sense, that is what our approach in section 3.3 implements. However, to come up with the path for the annual probability of stranding one needs to model the interaction between the path of cost recovery and the path of the annual probability of stranding. This interrelationship needs to be internal to the model rather than, as is the case in the Dixit and Pindyck framework, an exogenous assumption.[20]

55. Nonetheless, it relatively simple to model accelerated depreciation in the Dixit and Pindyck framework by simply assuming the cash-flows in question are a tilted perpetuity rather than a constant perpetuity. A perpetuity with a tilted revenue profile has revenues rising/falling annually by the relevant tilt (-5% tilt implies prices are falling by 5% annually).

56. In order to have a constant NPV, a perpetuity with a -5% (-30%) tilt must start with initial revenues that are roughly double (10-fold) higher than a constant perpetuity. This means that a perpetuity with a negative tilt has accelerated depreciation relative to a constant perpetuity (zero tilt).

[20] The approach in section 3.3 is to model the path of future regulatory cost recovery and the path of (probabilistic) future customer willingness to pay. This identifies an expected future date at which full recovery of regulated building block costs will not be possible and an associated estimate of the (present value) of expected under-recovery from that date on. Clearly, this changes as the path of cost recovery changes.

Table 1: Stranding uplift with different tilted perpetuities

Tilt	Stranding uplift required (assuming 80% risk of 100% stranding by 2050)
0%	5.75%
-5%	3.85%
-30%	1.45%

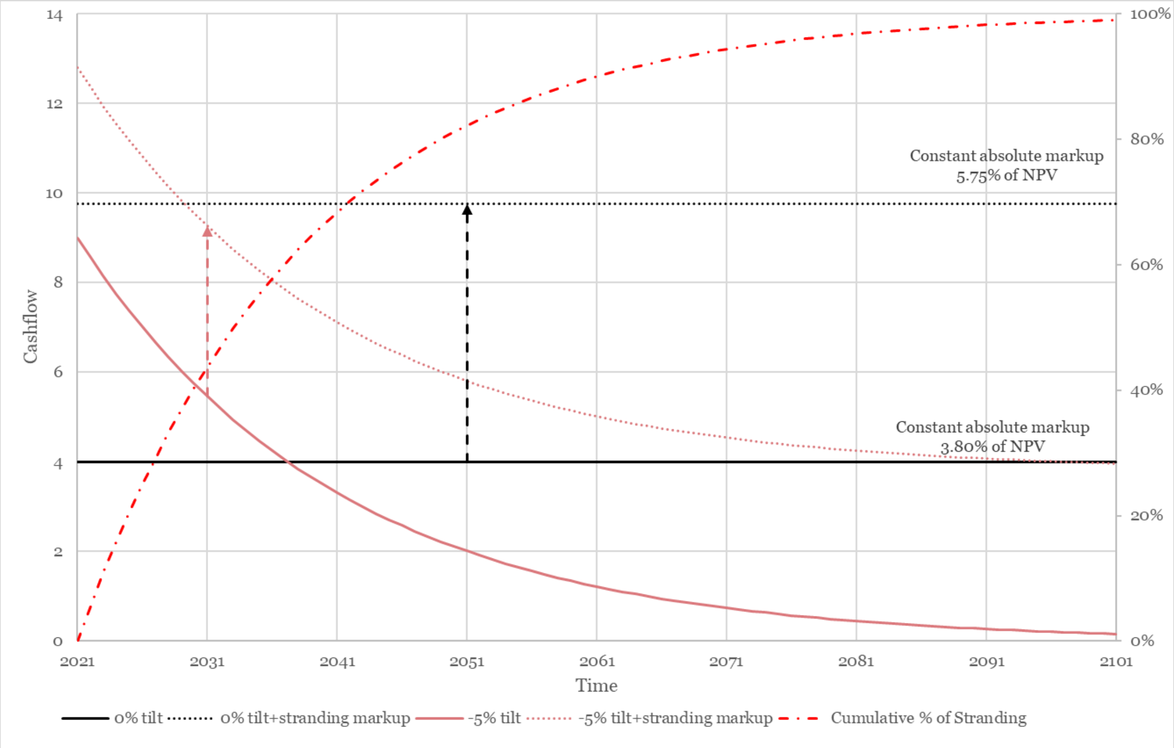
Source: CEG analysis

57. Even with extreme accelerated depreciation associated with a -30% tilt (a 10-fold increase in prices immediately to allow a 30% reduction in prices per annum) the required stranding uplift is still 1.45%.

58. As foreshadowed, this is because, under the Dixit and Pindyck's modelling assumptions, the probability of stranding by 2050 is just the accumulation of continuous constant risk of stranding per unit of time between now and then. In this model, the only way to eliminate stranding risk is for the regulator to allow immediate and instantaneous return of past investments. Any delayed recovery of investment creates stranding risk because stranding risk is assumed to be the same from one month to the next (indeed, from one minute to the next).

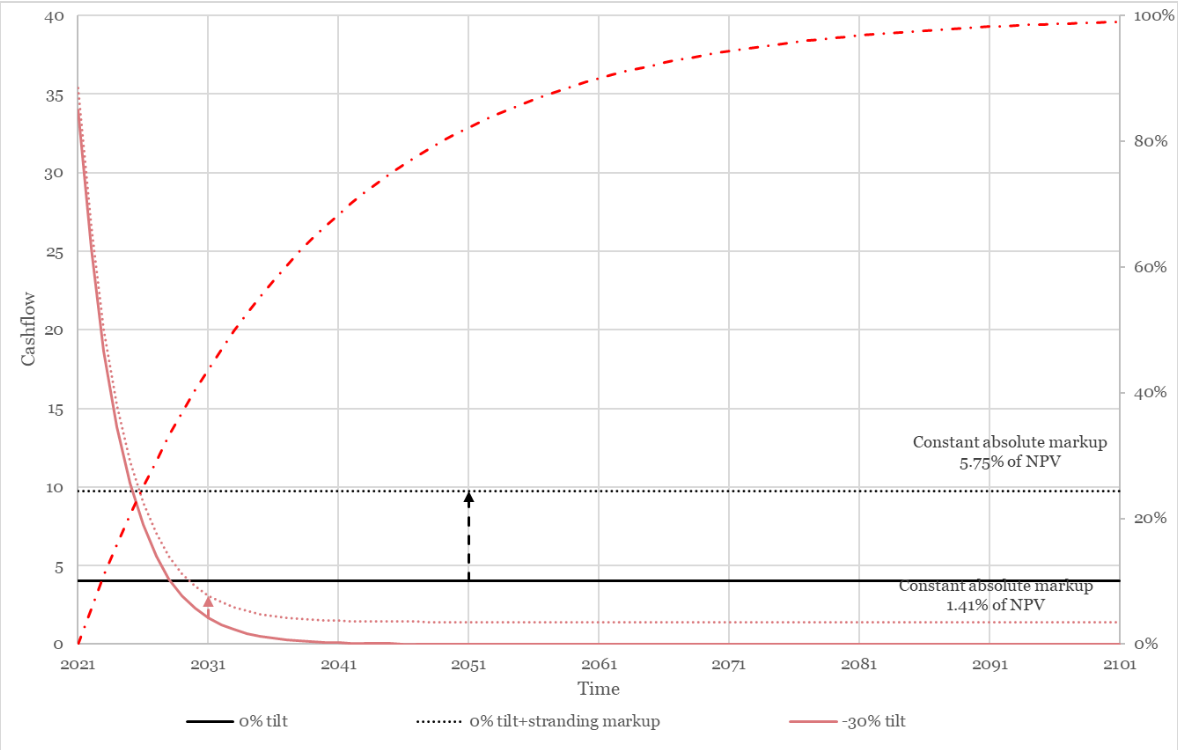
59. Figure 3-3 and Figure 3-4 below illustrate the -5% and -30% tilts graphically.

Figure 3-3: NZCC method – adapted to apply a -5% tilted perpetuity



Source: CEG Analysis

Figure 3-4: NZCC method – adapted to apply a -30% tilted perpetuity



Source: CEG Analysis

3.3 Modelling stranding cost by modelling the path of asset recovery and gas demand

60. Rather than assuming a constant annual probability of stranding. We introduce the concept of the maximum economically viable profit that can be obtained from the market. This can be thought of as customers' aggregate willingness to pay for gas pipeline services less the 'stay-in-business' operating expenditures of those businesses. This is the maximum amount that customers are willing to contribute to compensation for past sunk investments (above and beyond the compensation required for ongoing costs of providing the service).

3.3.1 Base case scenario

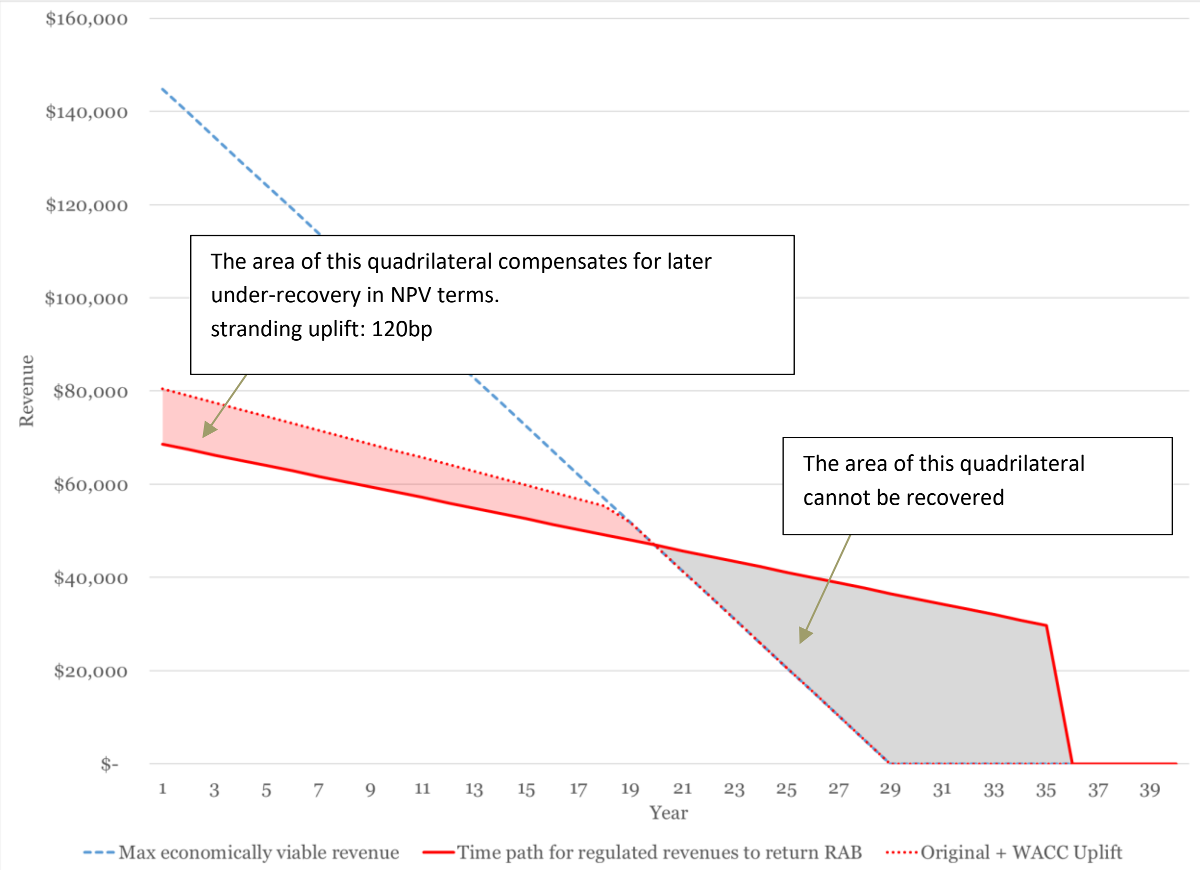
61. Figure 3-5 is the same as Figure 3-1 set out above. The solid red line illustrates the regulator's time path for recovery of sunk investments. The underlying assumption is that, at the beginning of year 1 there is $1,000,000 of unrecovered RAB and the real WACC is 4% (it is assumed that the RAB is inflation indexed so that all values in Figure 3-5 are in real "year 1" terms). It is also assumed that the regulator is depreciating the sunk RAB in a straight line over a 35 year remaining life with straight line depreciation. These assumptions imply the solid red line (building block costs) starts at $68,571 in year 1[21] for the return on, plus depreciation of, the sunk capital base in year one and falls to zero by the end of year 35 (beginning of year 36).

62. The dotted blue illustrates the path of customers' aggregate willingness to pay for the sunk investments. This line can be thought of as customers' willingness to pay 'as if' there is no opex or capex, or, more realistically, the blue line represents the maximum willingness of customers to pay for the recovery of sunk costs after all other variable costs are paid for. In this illustration, customers' initial aggregate willingness to compensate for sunk costs is $145,000 per annum – being roughly double the building block costs associated with sunk assets. However, this is assumed to fall, in a straight line, to zero 28 years later (28 years from 2022 is consistent with a possible 2050 policy target of reducing natural gas consumption by residential and commercial customers to zero).

63. The combination of the regulatory and market constraint on the recovery of sunk costs means that the ability of the regulated business to recover those costs is given by the minimum of the solid red line and the dotted blue line.

21 $40,000 in return on capital and $28,571 in straight line depreciation

Figure 3-5: Stranding uplift with 35-year remaining life for sunk assets



Source: CEG Analysis

64. If regulatory compensation is set to follow the solid red line, then there will come a point, in year 20, when customers are unwilling to pay the full building block costs – i.e., there is at least partial stranding of sunk investments at that point. If the regulator did not accelerate depreciation to remove this expected stranding cost (from year 20 onwards) it would need to add a stranding uplift of 120bp in the years prior to year 20 in order to compensate (in present value terms) for the stranding post year 20. This is the value that makes the top left quadrilateral have the same present value as the bottom right quadrilateral.

65. It should be clear from this presentation that, where the dotted blue line is known with certainty, the "stranding uplift" is, in essence, a form of "accelerated depreciation" by another name.

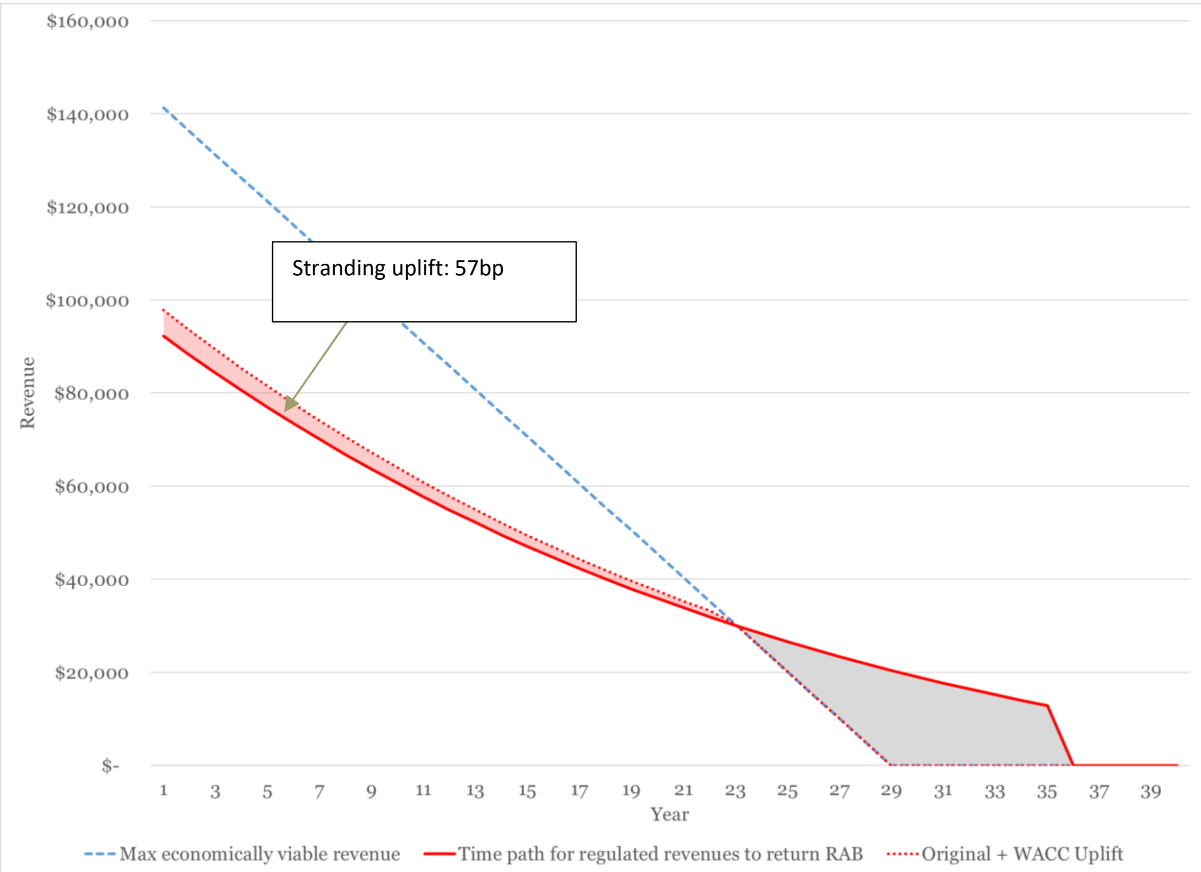
3.3.2 Accelerating cost recovery reduces the required stranding uplift

66. There are many ways in which accelerated cost recovery can be implemented within the confines of an NPV=0 building block regulatory building block. These include: shortening asset lives while retaining a straight line depreciation assumption; leaving

asset lives the same while moving from straight line to diminishing value depreciation; stopping indexing the RAB for inflation; or some combination of the above. This section examines the impact on economic stranding risk of adopting some of these methods for accelerating cost recovery. There are, of course, many more methods for accelerating cost recovery than we model in this section.

67. If the RAB is no longer indexed for inflation, then this accelerates cost recovery (higher return on assets now in return for a lower future RAB is a form of accelerated depreciation). Consequently, the solid red line is higher initially and lower in future (relative to the base case). This reduces the later stranding cost (the extent to which the solid red line is above the dotted blue line) and, therefore, reduces the required stranding uplift.

Figure 3-6: Removing indexation reduces stranding uplift from 120 to 57bp



CEG analysis, assumes 2.5% inflation.

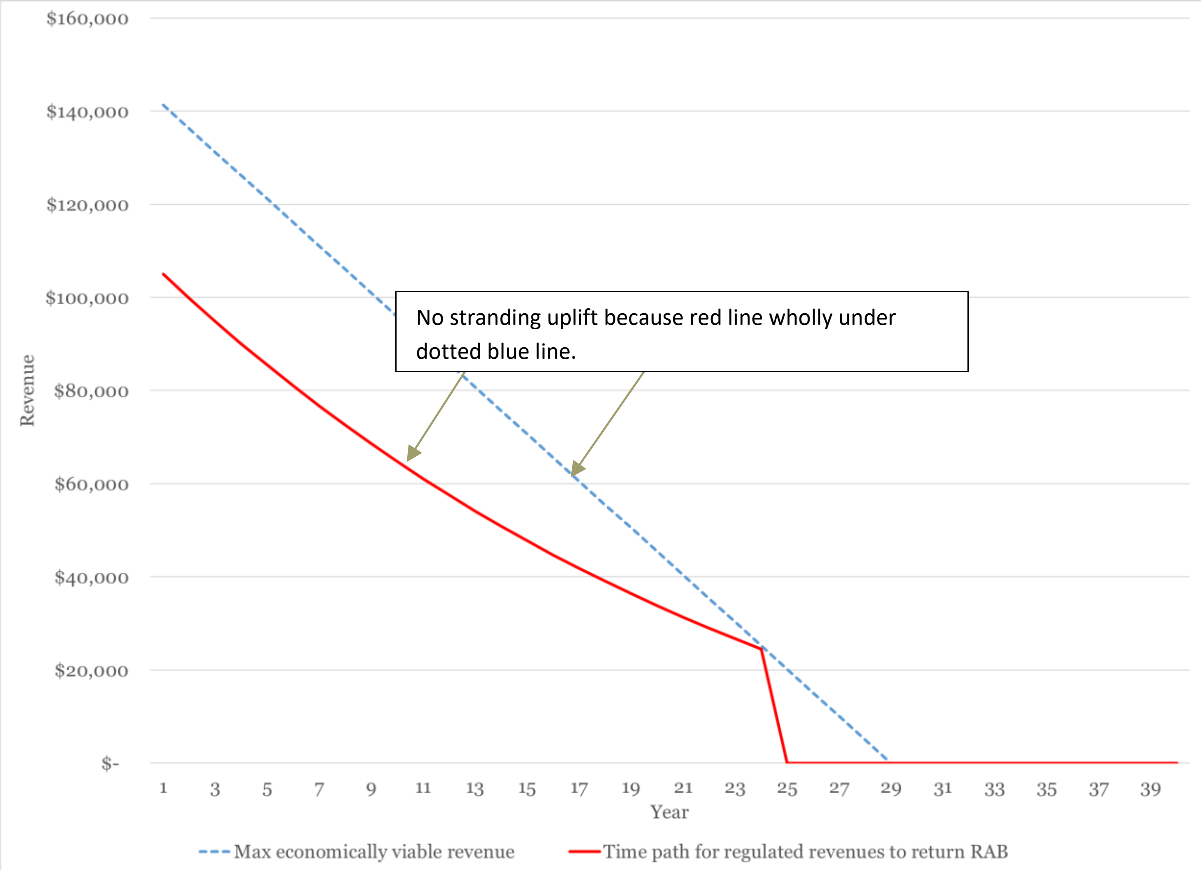
68. Removing inflation indexation has a similar effect on the pattern of cost recovery as does switching from straight line depreciation to diminishing value depreciation.[22] We do not model diminishing value depreciation in this section but, depending on how it was implemented, it could be thought of as a more tilted version of the red line that is depicted in Figure 3-7 above.

69. Removing inflation indexation from the base-case reduces, but does not eliminate, stranding risk (and the necessary stranding uplift). However, it should be clear, from visual inspection of Figure 3-6, that with more acceleration of cost recovery then economic stranding risk can be avoided (as can the need for the associated stranding uplift).

70. Figure 3-7 shows achieves this result by shortening asset lives to 24 years (down from 35). Combined with not indexing the RAB for inflation, this brings the solid red line wholly under the dotter blue line in all periods. Consequently, economic stranding is avoided and no stranding uplift is required. (This assumes we know the path customer willingness to pay with certainty – an assumption we will relax later).

22 Depending on how the base value in the formulae for diminishing value is determined.

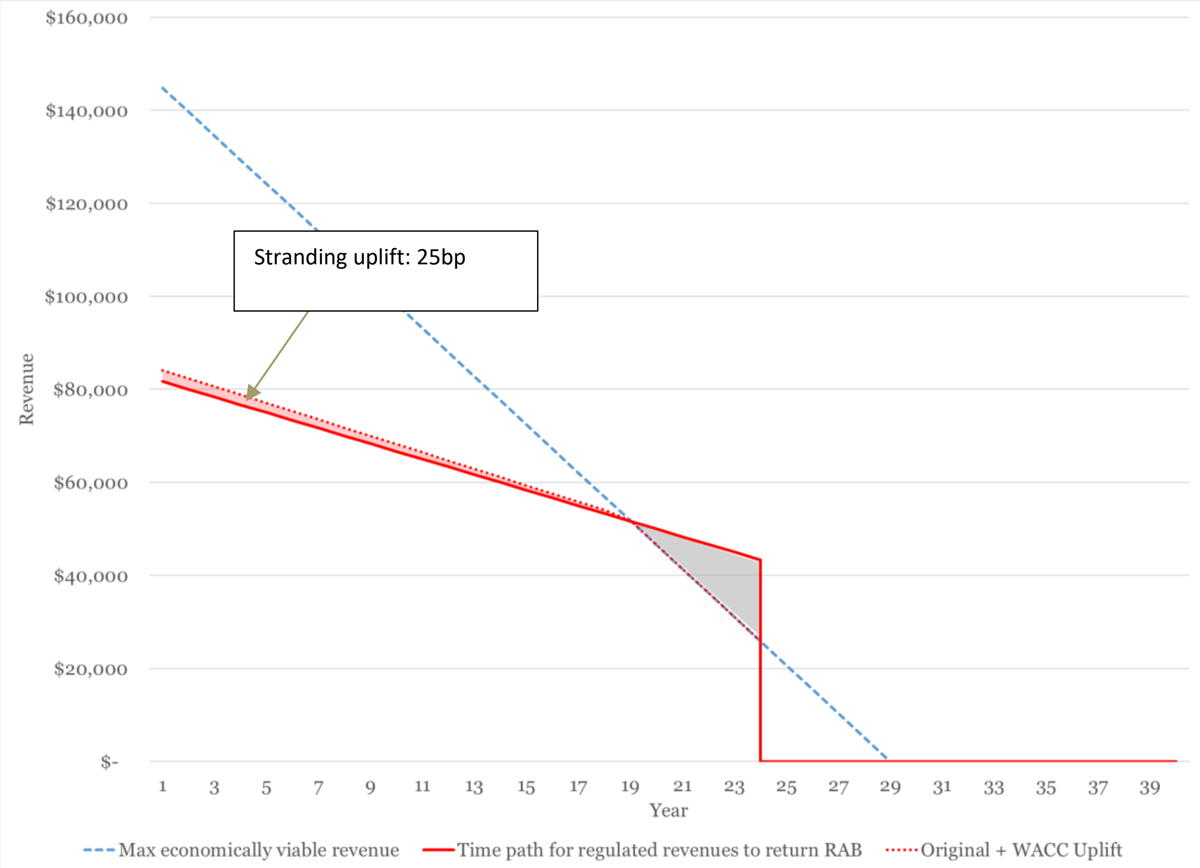
Figure 3-7: Removing indexation and reducing asset lives from 35 to 24 years eliminates uplift for stranding



CEG analysis, assumes 2.5% inflation.

71. By contrast, if the only reform implemented was to accelerate depreciation from 35 years to 24 years (but inflation indexation continued to be applied) then the stranding uplift required to compensate for future stranding cost would be 25bp. This scenario is illustrated in Figure 3-8 below.

Figure 3-8: Stranding uplift with 24 year remaining life for sunk assets



Source: CEG Analysis

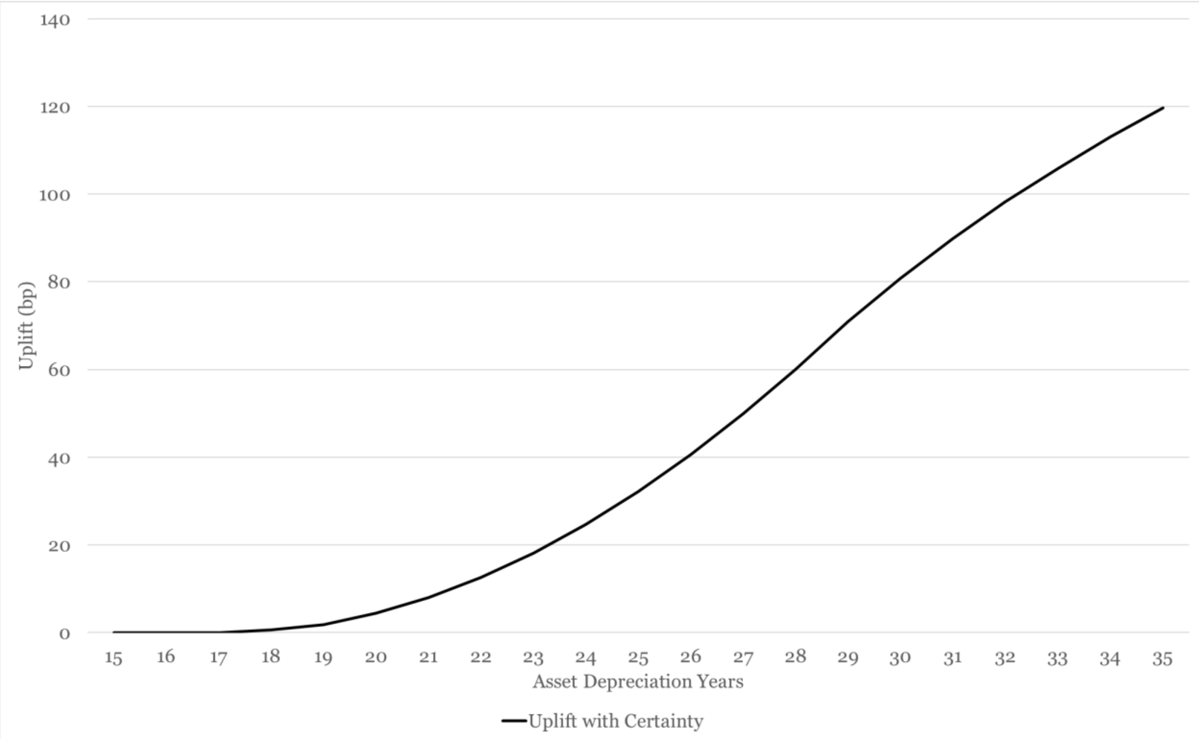
72. In the rest of this section, we show modelling assuming that the RAB continues to be indexed for inflation. Naturally, and as illustrated above, for any given rate of depreciation, if the RAB ceased to be indexed for inflation the required stranding uplift would be lower.

73. Figure 3-9 below illustrates the general relationship between the rate of accelerated depreciation and the required stranding uplift (assuming that indexation of the RAB continues). The vertical axis is the required stranding uplift, and the horizontal axis is the remaining life over which the outstanding RAB is depreciated. A low value on the horizontal axis indicates high levels of accelerated depreciation. The underlying assumptions in Figure 3-9 are the same as in Figure 3-5 to Figure 3-8 with the only factor varying being the rate of accelerated depreciation.

74. The stranding uplift at zero with high rates of accelerated depreciation having the effect of making the time-path of regulatory compensation fall wholly below the time-path for customers' willingness to pay (given the underlying assumptions of Figure 3-5 to Figure 3-8). However, as the time horizon over which the RAB is depreciated is increased, the required stranding uplift rises - indicating that the time-path for regulatory compensation crosses above the willingness of customers to pay at some

point in the future. The longer the time horizon over which the RAB is depreciated the earlier that point is and the greater the value of the depreciated RAB that is subject to stranding at that point.

Figure 3-9: Modelled stranding uplift as accelerated depreciation varies (assuming indexation of the RAB continues)



Source: CEG Analysis

75. In the scenario being modelled there is always some stranding uplift that can fully compensate for stranding risks. This is because, in this scenario, the present value of customers' willingness to pay (the present value of the area under dotted blue line in earlier figures) is greater than the value of the sunk RAB at the beginning of year 1 (which is also the present value of the area under solid red line). Provided this is true, there is always some combination of depreciation rate and stranding uplift that can fully recover the value of sunk investments.

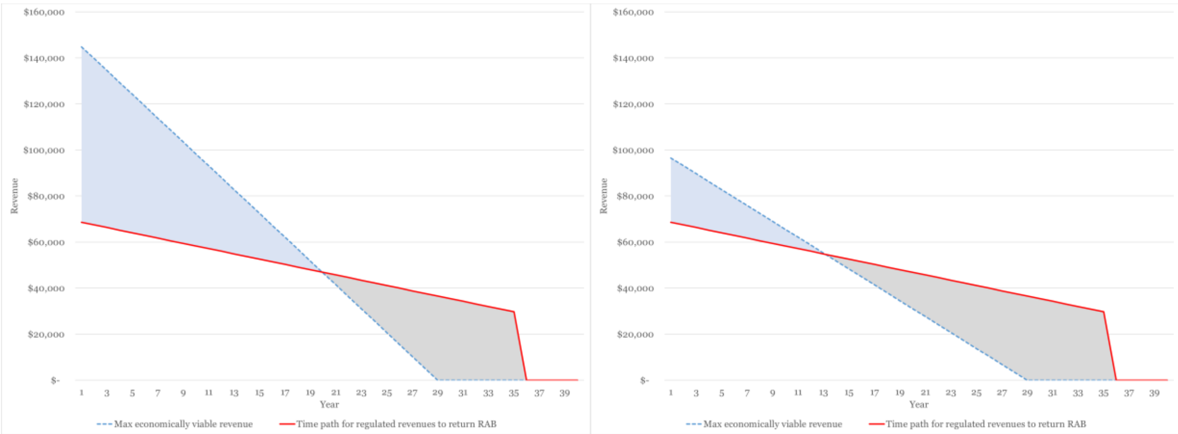
3.3.3 Stranding can be unavoidable (unable to be compensated for)

76. It may not always be possible to avoid asset stranding by accelerating depreciation. Specifically, if there is limited "headroom" between the dotted blue (customer willingness to pay) and the solid red (regulatory compensation) lines – even in early years – then accelerating depreciation may simply push regulatory compensation above customers' willingness to pay earlier. In this situation it is impossible to compensate fully for expected future stranding by either:

- Accelerating depreciation;
- Providing a stranding uplift; or
- Any combination of the above.

77. This situation is illustrated in Figure 3-10 below. In Figure 3-10 the reed lines in both panels have the same regulatory compensation path as Figure 3-5 but, in the right hand panel, the aggregate customer willingness to pay (dotted blue line) is lower (starting value of $97,000 instead of $145,000) and now falls under the path for regulatory compensation in the 13th year rather than the 20th year).

Figure 3-10: Asset stranding is unavoidable



Source: CEG Analysis

78. In this scenario, a level of economic asset stranding is unavoidable (has already happened). Even if regulation were completely removed the (formerly) regulated business would be unable to fully recover the value of its sunk assets.

79. This is because, in the right-hand panel, the blue shaded area has smaller NPV than the grey shaded panel. The value of asset stranding is given by the present value of the difference between the solid red and dotted blue lines. The value of asset stranding cannot be eliminated, only reduced, by changing the tilt (rate of depreciation) of the solid red line.

80. In this situation, even if regulation was removed, the regulated business would be unable to recover the value of their sunk investment. The only affect a regulator can have on the value of asset stranding is to increase it. This will be the case if the regulator forces compensation below the dotted blue line in the early years. If this is done the value of asset stranding is increased by the difference between regulated compensation and customers' willingness to pay in those years that regulated compensation is below customers' willingness to pay.

3.3.4 Stranding that is preventable now will be unavoidable in the future if depreciation is not accelerated

81. Avoidable asset stranding may turn into unavoidable asset stranding if a regulator delays taking action to accelerate depreciation. This can be illustrated by reference to Figure 3-5 and Figure 3-10 above. In Figure 3-5 the path for regulatory compensation is set such that it passes above customers' willingness to pay in future decades. This problem is remedied in Figure 3-7 by immediately, in 2022, removing inflation indexation and accelerating depreciation to raise regulatory compensation now and lower it in the future – such that it never passes above customers' maximum willingness to pay.

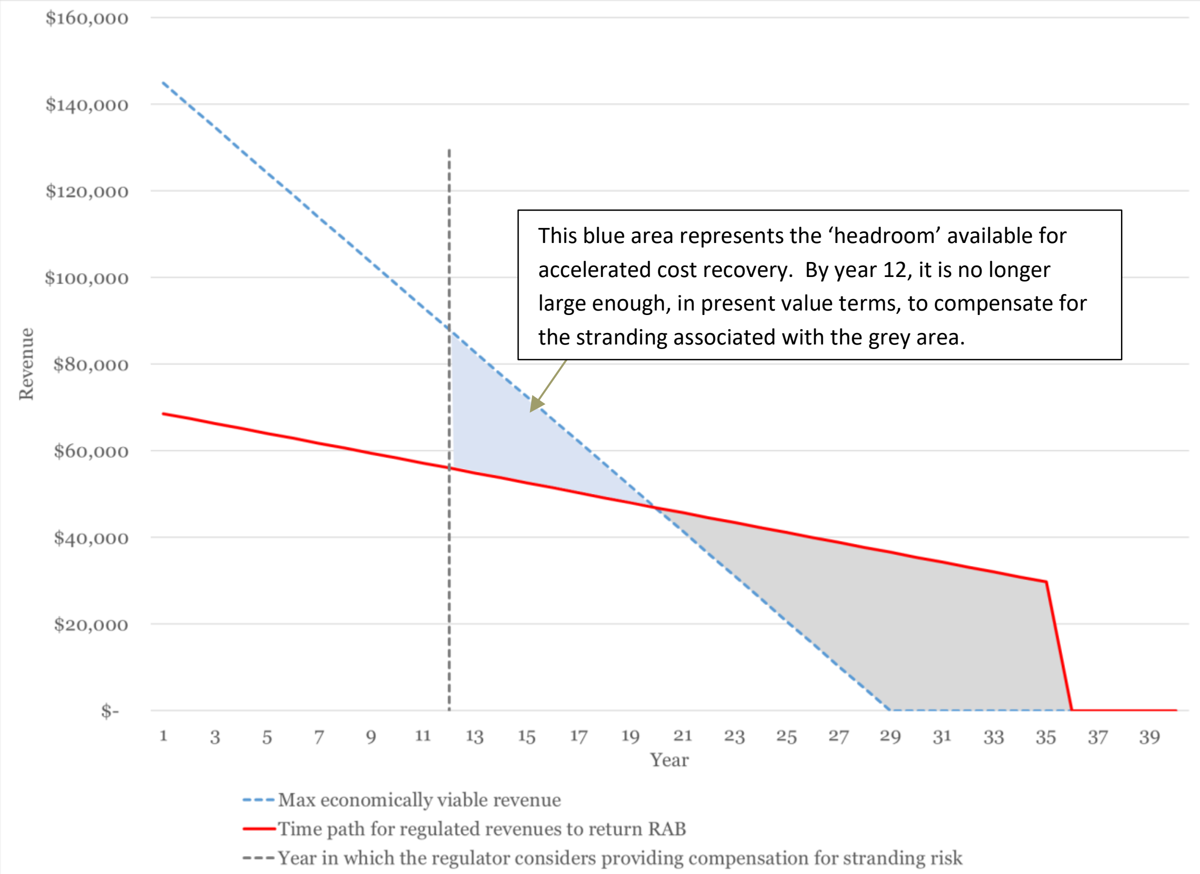
82. However, if the regulator delays providing accelerated depreciation immediately avoiding stranding risk may not be possible in future years. Figure 3-7 and Figure 3-11 share the same underlying assumptions about the initial level of sunk costs and the path of customer willingness to pay. The difference is that, in Figure 3-7, the regulator immediately implements accelerated recovery of sunk costs (ceases indexation and reduces asset lives) to eliminate stranding risk.

83. Figure 3-11 shows what happens if the regulator delays the decision to accelerate cost recovery for 12 years. By that time:

- the value of sunk assets unrecovered in year 12 is greater than the sum of present value of customers' willingness to pay in all subsequent years;
- this means that, even if depreciation is accelerated (or a stranding uplift applied) to allow the maximum possible cost recovery (given by the height of the dotted blue line at year 12 years).

84. Geometrically, the present value of the area in the light blue triangle is the maximum additional value that can be derived from higher regulated revenues relative to staying on the default time path for compensation (the solid red line). However, because the light blue triangle is smaller (in present value terms) than the grey quadrilateral this will not fully compensate for the unrecovered costs associated with the default time path.

Figure 3-11: Regulatory delay in accelerating depreciation makes stranding unavoidable



Source: CEG Analysis

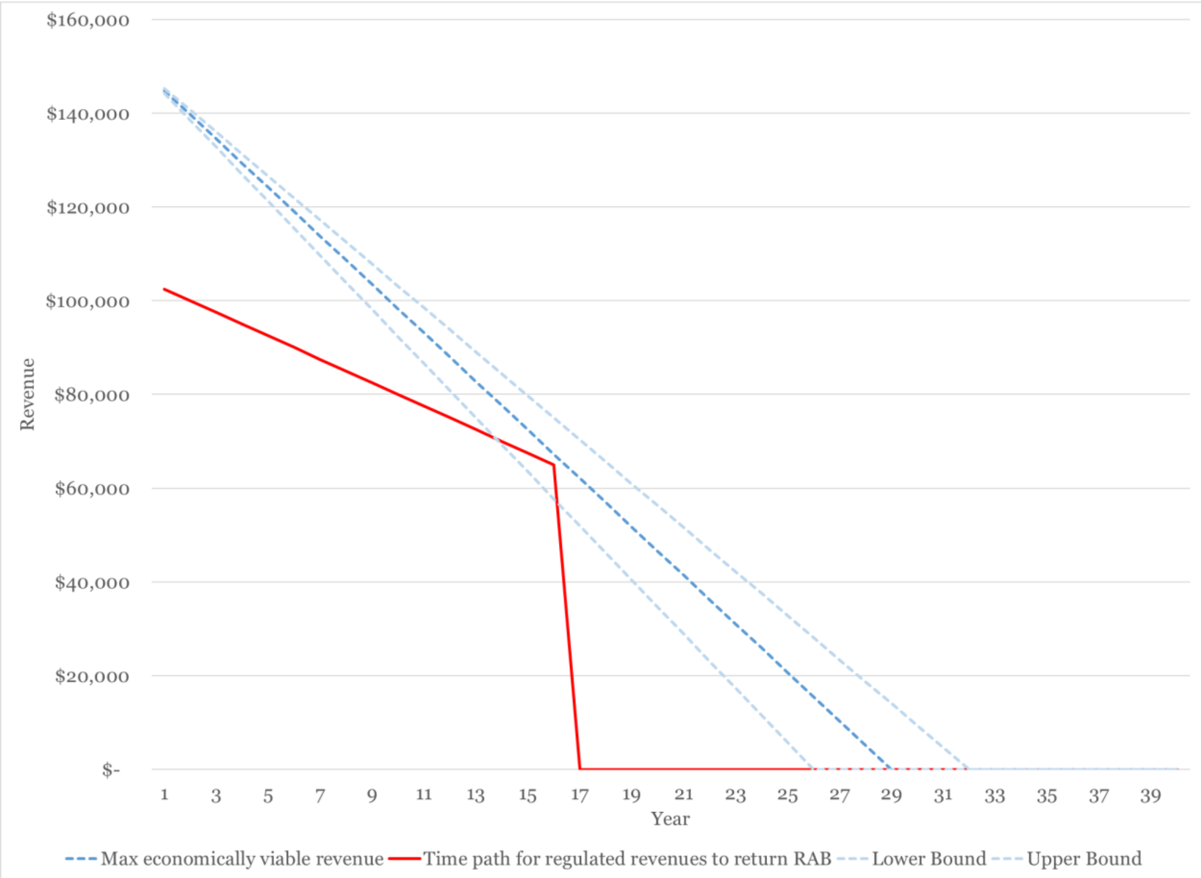
3.3.5 Introducing uncertainty into the model

85. In the above illustrative modelling, we have proceeded as if there was a single known time path for customers' aggregate willingness to pay.[23] However, in reality there is material uncertainty around the path that willingness to pay may take.

86. Even if we had an accurate estimate of the most likely (average) time path for customers' willingness to pay, solely relying on that single (average) time path in the modelling would be problematic. This is illustrated in Figure 3-12 below; in which the darker dotted blue line can be viewed as the average path and the two lighter blue lines around it can be viewed as the worst case and best-case scenarios.

23 Or, more exactly, willingness to pay above and beyond that need to cover ongoing operating costs of providing the service.

Figure 3-12: Modelling stranding compensation with uncertainty



Source: CEG Analysis

87. In this example, comparing the solid red line solely with dark blue (average) path for willingness to pay will result in a conclusion that asset stranding risk has been eliminated (the stranding uplift can be set to zero). This is because the solid red line lies wholly beneath dark blue dotted line.

88. However, this approach ignores the fact that, under the worst-case scenario, some of the allowed revenue will not be recovered. This means that there is some, non-zero, probability of asset stranding. Consequently, either:

- Depreciation would need to be accelerated even further so that, even in the worst-case scenario, the solid red line is below the dotted blue line; or
- A positive stranding uplift would need to be estimated based on the expected value of asset stranding (being the area of the solid red line above the light blue dotted line multiplied by the probability of this sort of "worst case" scenario occurring).

89. This illustrates the fact that the correct estimate of the appropriate stranding uplift is heavily dependent on two difficult to know values:

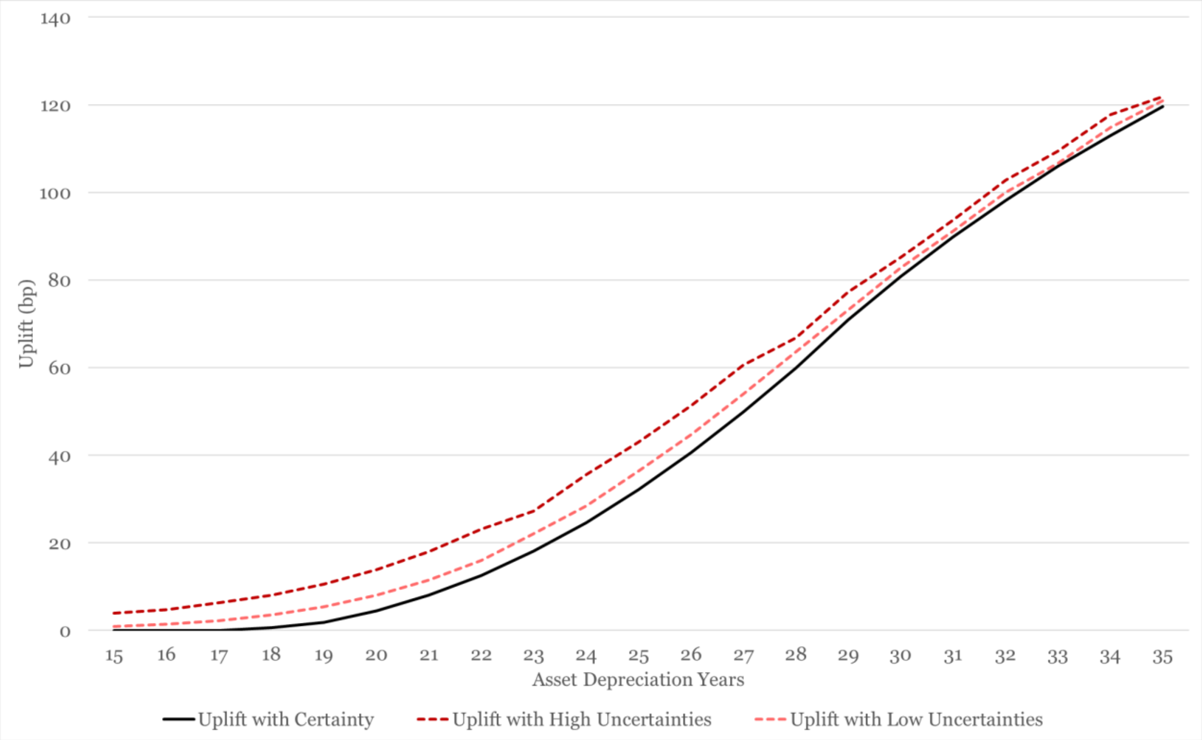
- The expected path of customer willingness to pay; and
- The distribution of (uncertainty around) the expected path of customer willingness to pay.

90. Figure 3-13 demonstrates this. In both Figure 3-13 and Figure 3-9 the solid black line is the same and shows the relationship between the required stranding uplift and the time horizon over which the RAB is depreciated. However, in Figure 3-13 we also show the additional impact of uncertainty on the required stranding uplift – in the form of the dotted pink and dotted red lines. The dotted pink and the dotted red lines each show the impact of different levels of uncertainty. In all cases we assume a base case where the most likely outcome is a linear trend towards customers having a zero willingness to contribute towards sunk costs (i.e., above and beyond operating costs) by 2050 (28 years).

91. The two uncertainty scenarios we model assume a uniform distribution of possible outcomes around that most likely case:

- Low uncertainty scenario – the best/worst case is that willingness to pay falls to zero by 2047//2053 (± 3 years from 2050). This uncertainty gives rise to the need for a higher uplift (relative to the zero-uncertainty black line) illustrated by the dotted pink line; and
- High uncertainty - the best/worst case is that willingness to pay falls to zero by 2045//2055 (± 5 years from 2050). This higher uncertainty gives rise to the need for a higher uplift (relative to the low uncertainty dotted pink line) illustrated by the dotted red line.

Figure 3-13: Modelled stranding uplift with and without uncertainty



Source: CEG Analysis